ELSEVIER

Surgery for Obesity and Related Diseases 10 (2014) 277–283

SURGERY FOR OBESITY AND RELATED DISEASES

Original article

Effects of laparoscopic sleeve gastrectomy on attentional processing of food-related information: Evidence from eye-tracking

Katrin E. Giel, Ph.D.[a,*], Nicole Rieber, Ph.D.[a], Paul Enck, Ph.D.[a], Hans-Christoph Friederich, M.D.[b], Tobias Meile, M.D.[c], Stephan Zipfel, M.D.[a], Martin Teufel, M.D.[a]

[a]*Department of Psychosomatic Medicine and Psychotherapy, Medical University Hospital Tübingen, Tübingen, Germany*
[b]*Department of General Internal Medicine and Psychosomatics, University Hospital Heidelberg, Heidelberg, Germany*
[c]*Department of General, Visceral and Transplant Surgery, University Hospital Tübingen, Tübingen, Germany*

Received April 4, 2013; accepted September 14, 2013

Abstract

Background: Weight loss after laparoscopic sleeve gastrectomy (LSG) might be associated partially with changes in reward system functioning and altered appetitive responses to food cues. Food cue processing refers to motivational, affective, and cognitive responses to stimuli that are associated with food. We investigated if food cue processing is altered 6 months after weight loss that is induced by LSG. We expected patients after LSG to show reduced appetitive responses to food cues.

Methods: In an experimental longitudinal exploratory study, 17 severely obese patients (body mass index [BMI]: 48.3 ± 6.5 kg/m²) were investigated presurgery and 6 months postsurgery. We used eye-tracking to assess attentional biases during free viewing of food versus nonfood cues, assessed pleasantness ratings of food cues, and self-reported food craving.

Results: After LSG, the mean BMI of patients was 36.4 ± 6.0 kg/m², and the percentage of excess weight loss (%EWL) was 46.6% ± 14.0%. Six months after LSG, patients showed an attentional bias toward nonfood cues compared with presurgery, reported lower food craving, and rated presented food stimuli as less pleasant.

Conclusion: Evidence of altered food cue processing was found in patients after LSG, which may be interpreted as reduced food reward associated with increased cognitive control. Surgery-induced physiologic, cognitive-motivational, and behavioral changes may lead to a desensitization of the reward system and enhanced cognitive control. (Surg Obes Relat Dis 2014;10:277–283.)

Keywords: Attention; Bariatric surgery; Craving; Eye-tracking; Food; Laparoscopic sleeve gastrectomy; Obesity; Reward; Weight loss

It has been recently suggested that the pronounced weight loss after bariatric surgery could be partially related to changes in reward system functioning and associated alterations in the appetitive response to food cues [1]. Bariatric surgery is associated with complex physiologic and behavioral consequences, e.g., consequences that affect endocrinological circuits, especially in gut hormones and metabolic functioning, as well as nutritional adaptations [1–2]. Conceivably, many of these consequences result in altered food cue processing [1,3]. Food cue processing refers to motivational, affective, and cognitive responses to stimuli that are associated with food.

Cross-sectional experimental studies have shown modified reactions to food cues in obese compared with normal-weight individuals, suggesting a dysregulation of systems involved in reward and emotion processing and cognitive control in obesity [4–9]. There is initial evidence that these

*Correspondence: Katrin Giel, Ph.D., Department of Psychosomatic Medicine and Psychotherapy, Medical University Hospital Tuebingen, Osianderstrasse 5, 72076 Tübingen, Germany.
E-mail: katrin.giel@med.uni-tuebingen.de

1550-7289/14/$ – see front matter
http://dx.doi.org/10.1016/j.soard.2013.09.012

dysregulations are ameliorated after bariatric surgery, as shown by means of changes in food cue processing. These postsurgery changes, for instance, include a decreased preference of high-caloric food in rats [10–11], a reduced hedonic evaluation of high-caloric food in rats and humans [3,10,12], reduced food cravings in humans [13–15], and again in human studies, decreased brain activity in response to food cues in regions associated with reward processing [12,16,18] and increased brain activity in regions associated with inhibitory control [12,16,17].

To investigate mechanisms and predictors of success and failure of weight loss, longitudinal studies on food cue processing in patients undergoing bariatric surgery are crucial, but still widely lacking [1,3,4,18]. Currently, most data stem from animal models. The few experimental human studies have used sophisticated paradigms and methods and have shown promising results; however, they have been limited by short follow-up periods [3,12,16,18]. In the present study, an intermediate-term follow-up of 6 months (188.2 ± 23.1 days) after surgery was conducted.

In the present exploratory study, food cue processing was investigated in obese patients before and 6 months after laparoscopic sleeve gastrectomy (LSG). Food cue processing was assessed by means of an attentional bias for food cues, pleasantness ratings for food cues, and self-reported food craving. An attentional bias reflects the tendency to preferentially allocate attention to food compared with nonfood cues and can be understood as an appetitive response toward rewarding stimuli [5,19,20]. One method of unfolding such attentional biases is eye-tracking. Eye-tracking is a noninvasive method that allows for the assessment of gaze behavior. Gaze behavior is an indicator of overt visual attention deployment. Compared with other experimental methods assessing attentional processing, eye-tracking provides direct insight into visual attention with a high temporal resolution and is, hence, considered to be an especially objective and ecologically valid approach.

We hypothesized that study participants would show a reduced attentional bias toward food cues in the initial orienting and maintenance of attention, reduced food craving, and decreased pleasantness ratings of food cues 6 months after LSG relative to the presurgery data.

Methods

Participants

We recruited 24 obese patients from the Comprehensive Obesity Treatment Centre of a university hospital who were receiving LSG according to current treatment guidelines [21]. LSG is a bariatric surgery procedure with increasing popularity [22]. According to a recent large-scale survey, LSG is currently the second most common procedure used in bariatric surgery after Roux-en-Y gastric bypass [22]. Data from a recent review show that an average excess weight loss (EWL) of 56% after 12 months and 61% after 24 months is expected after LSG [23]. Of the 24 included patients, 3 patients were lost to follow-up and 4 patients were excluded because of poor quality of gaze data, resulting in a sample of 17 patients.

Table 1
Categorization of 30 food items according to flavor, caloric content, and fat content

Category	n	Example
Flavor		
Savory food	17	Fish & chips
Sweet food	13	Chocolate bar
Caloric Content		
High-caloric food	15	Pizza
Intermediate-caloric food	12	Pasta
Low-caloric food	3	Crispbread
Fat Content		
High-fat food	15	Brownie
Intermediate-fat food	12	Pretzel
Low-fat food	3	Lettuce

Food cues

Participants were presented with 30 pairs of color pictures, consisting of a food and a nonfood picture closely matched for color and visual complexity. To account for possible intolerance for specific food after surgery, depicted food items covered a wide range of various food categories, including sweet and savory foods from the whole caloric spectrum from low-energy to high-energy foods; Table 1 shows categorization and examples of food items. Nonfood pictures depicted household items (e.g., tooth brush, rubber bands). All items were presented on a white plate against a blue background. These stimuli were pretested and previously used by our work group in eating disorder research [20,24]. Stimulus pairs were presented in random order and balanced positions in 2 opposing corners of the screen.

Experimental task

The experiment comprised 30 trials in a single session. A central fixation cross presented for 2000 ms on the screen was followed by a stimulus pair presented for 3000 ms. Participants were asked to explore the stimulus pairs as if they were watching television. Gaze behavior was assessed using the remote eye-tracking system iView X Hi-Speed (SensoMotoric Instruments GmbH, Berlin, Germany). After task completion, participants were asked to evaluate the pleasantness of the randomly presented food stimuli using a visual analog scale (VAS) ranging from –10 (maximum unpleasant) to +10 (maximum pleasant). Participants were instructed to indicate on this VAS how pleasurable they perceive the depicted food item at present.